



DIESEL PARTICULATE MATTER (DPM) SAMPLING



OBJECTIVES

DPM Sampling Only - Not Intended To Be Comprehensive IH Training

- ❖ **DPM Sampling Requirements - §57.5071**
- ❖ **MSHA Compliance Sampling Procedures**
- ❖ **DPM Sampling Equipment**
- ❖ **Sample Analysis & Interpretation**

§57.5071 *Environmental Monitoring* does not specify sampling or analytical method

Must identify overexposures to PEL

DPM Sampling Per §57.5071

- ❖ **Sample as often as necessary to determine whether exposures exceed the applicable PEL**
- ❖ **Miners have option of observing sampling**
- ❖ **If exposure exceeds PEL, operator must**
 - **Post corrective action**
 - **Initiate corrective action by next work shift, and**
 - **Promptly complete corrective action**
- ❖ **All sampling results must be posted and copy provided to miner's representative**
- ❖ **Records of sampling method and sampling results must be retained for 5 years**

DPM Sampling & Analytic Methods

- ❖ **Gravimetric (weight)**
- ❖ **Submicron dust (size selective + weight)**
- ❖ **Respirable combustible dust (weigh, burn off combustibles, then re-weigh)**
- ❖ **Weighing-based systems not accurate enough at low DPM concentrations**
- ❖ **Submicron sampling + carbon analysis**
 - **NIOSH method 5040**
- ❖ **This presentation focuses on MSHA compliance sampling**

DPM Sampling Compliance Sampling

- ❖ **Equipment and procedures used by MSHA for DPM compliance sampling are fully described in the MSHA MNM Health Inspection Procedures Handbook – Chapter 22**
- ❖ **Handbook accessible on-line at:**
[http://www.msha.gov/READROOM/HANDBOOK/PH06-IV-1\(1\)MNMHealthInspectionProc.pdf](http://www.msha.gov/READROOM/HANDBOOK/PH06-IV-1(1)MNMHealthInspectionProc.pdf)

DPM SAMPLING OVERVIEW

- ❖ Use sampling pump to draw air through tandem quartz fiber filters
- ❖ Filters captures DPM, which is analyzed for organic and elemental carbon (OC & EC)
- ❖ OC on dynamic blank subtracted from OC on sample filter
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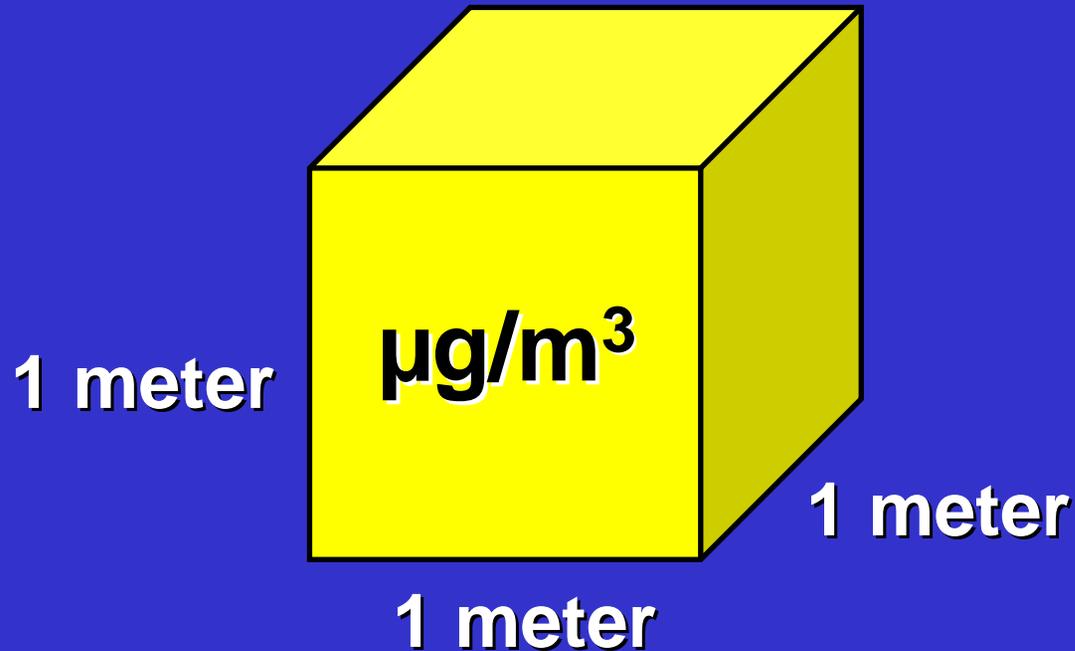
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Units of Measurement

Micrograms per cubic meter of air



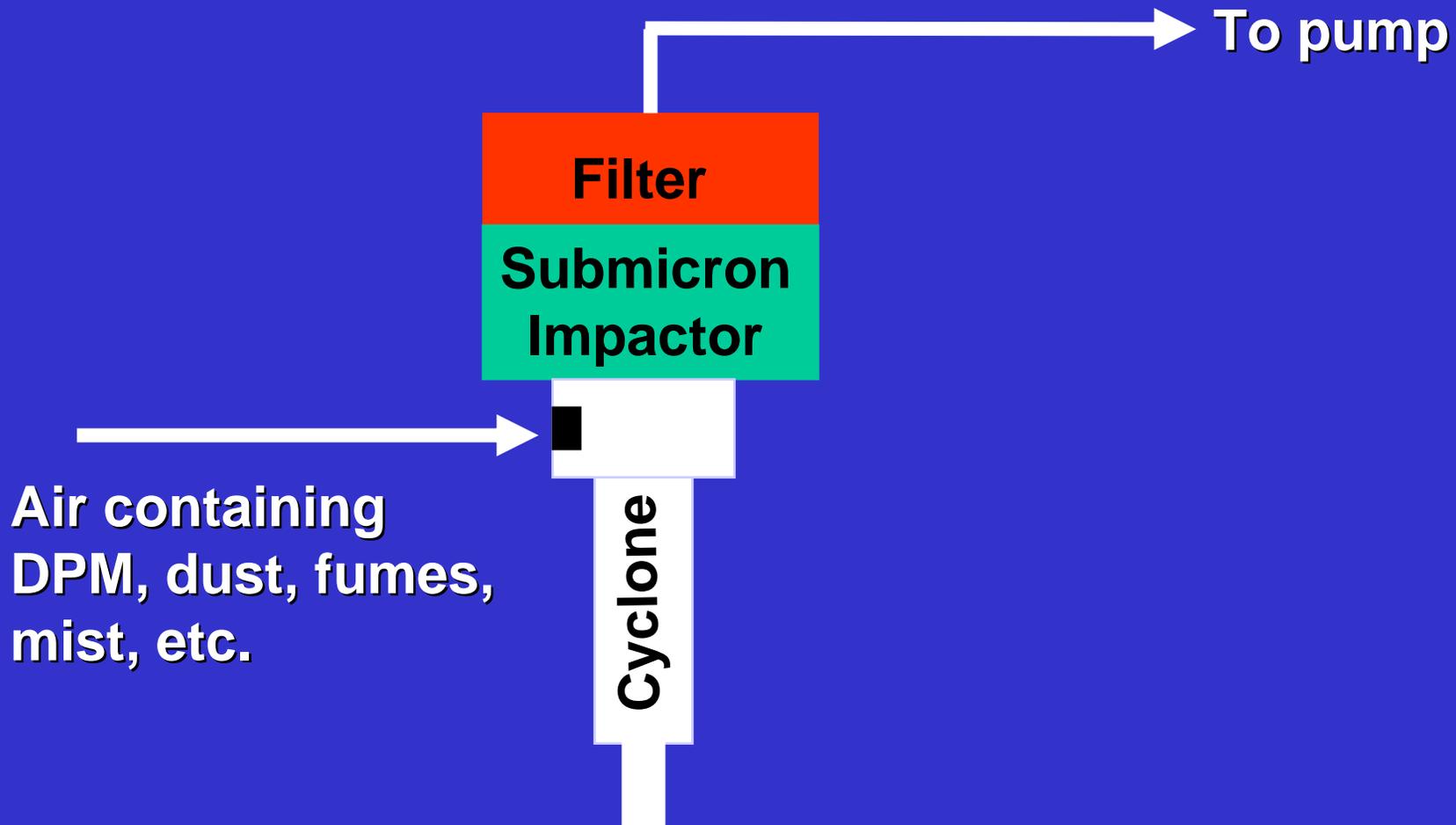
$$1 \text{ microgram} = \frac{1}{\text{millionth}} \text{ gram} = \frac{35}{\text{billionth}} \text{ oz}$$

DPM Sampling

Collect only Submicron particulates
to eliminate mineral dust interference

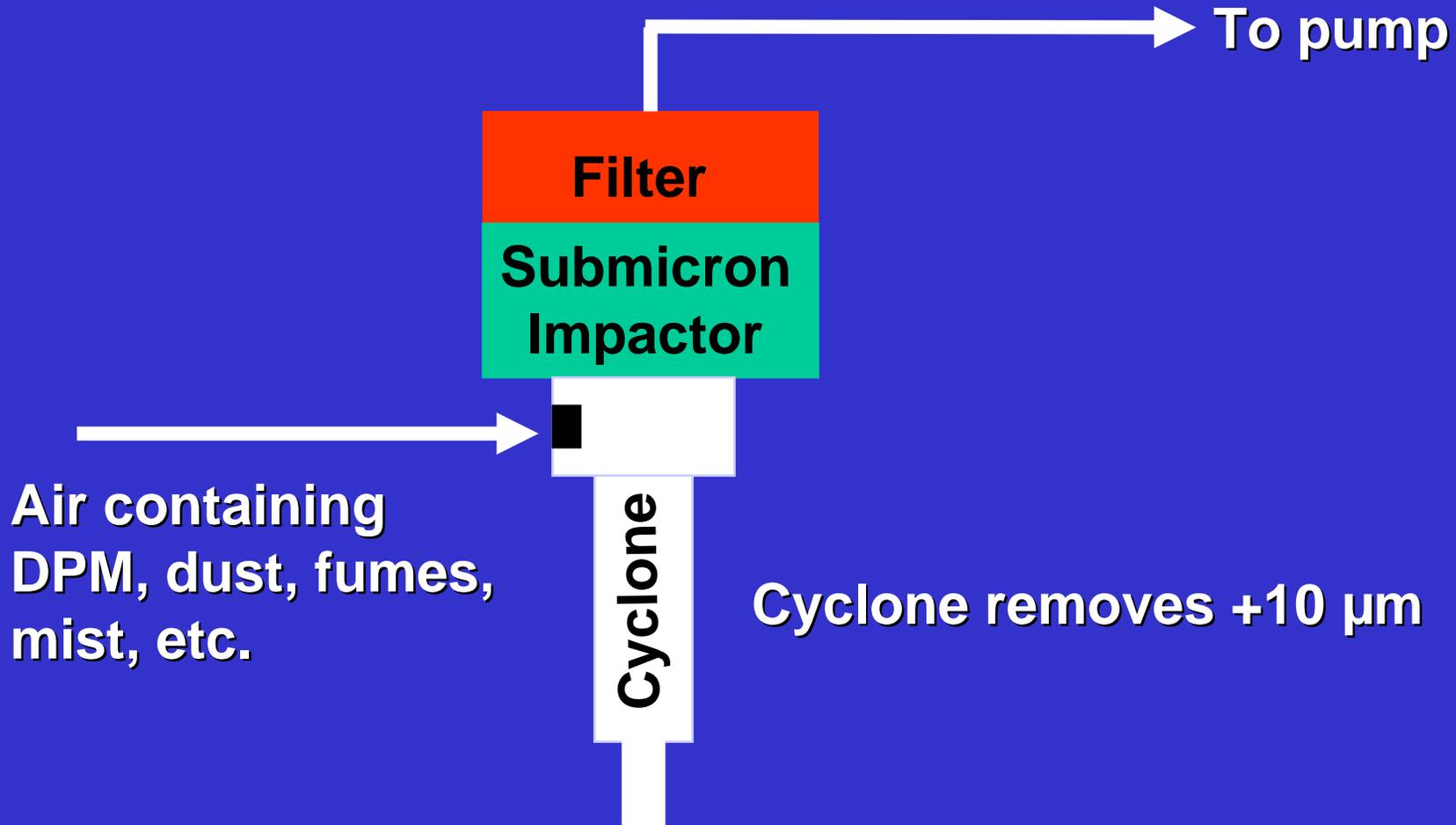
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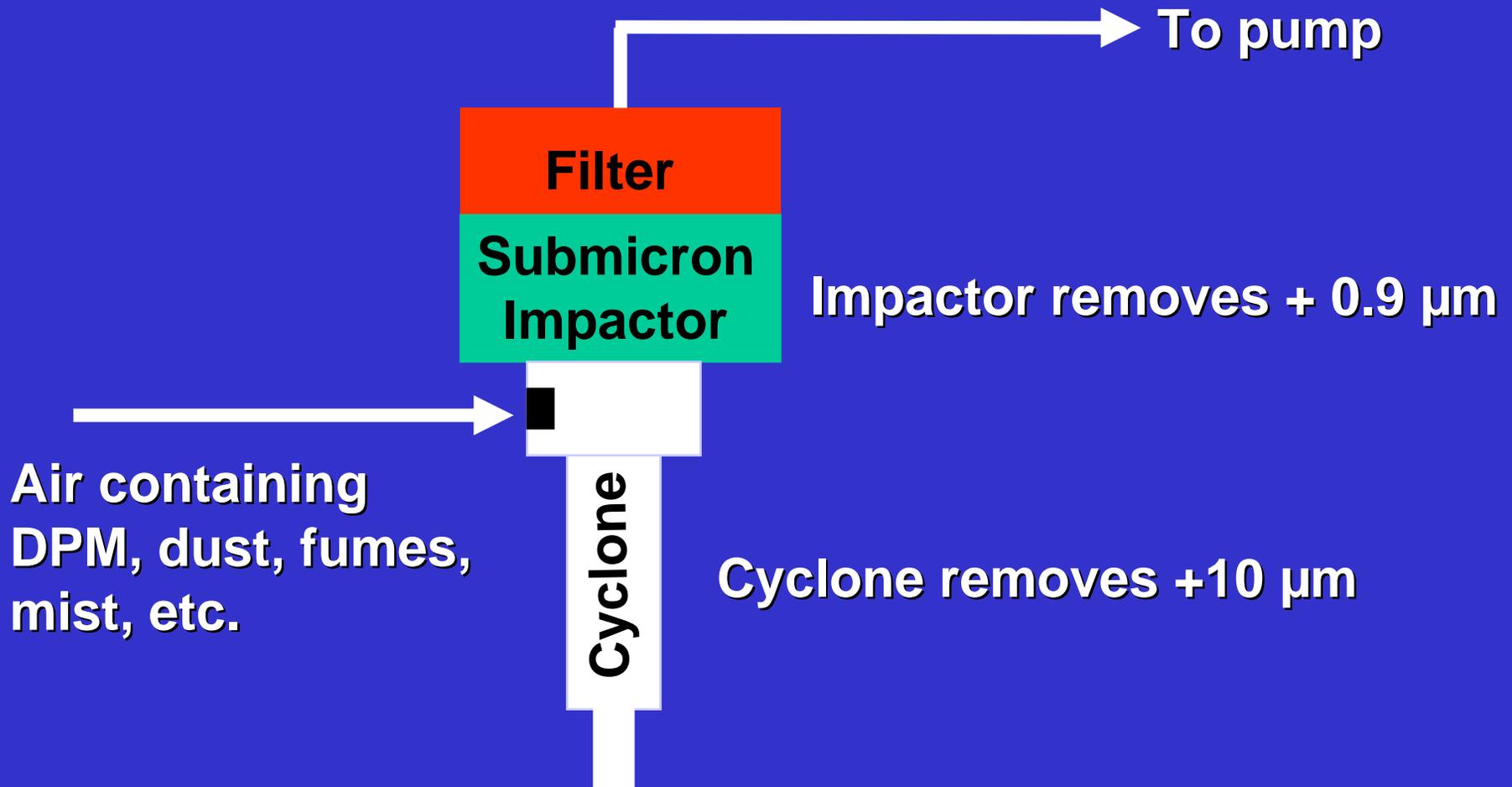
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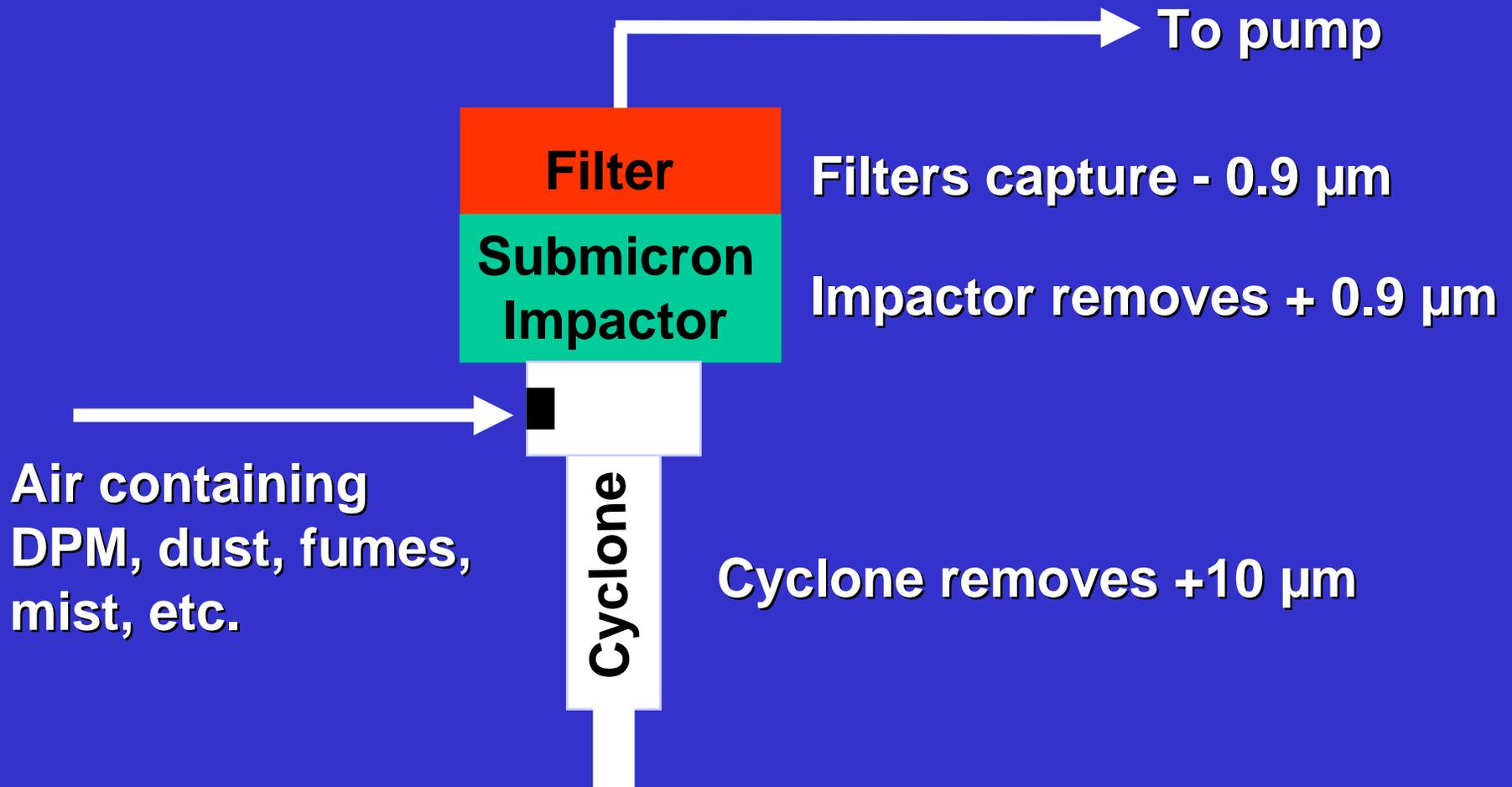
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Filter

**Submicron
Impactor**

DPM Sampling

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Send filter to lab for analysis

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Lab analyzes filter for OC & EC

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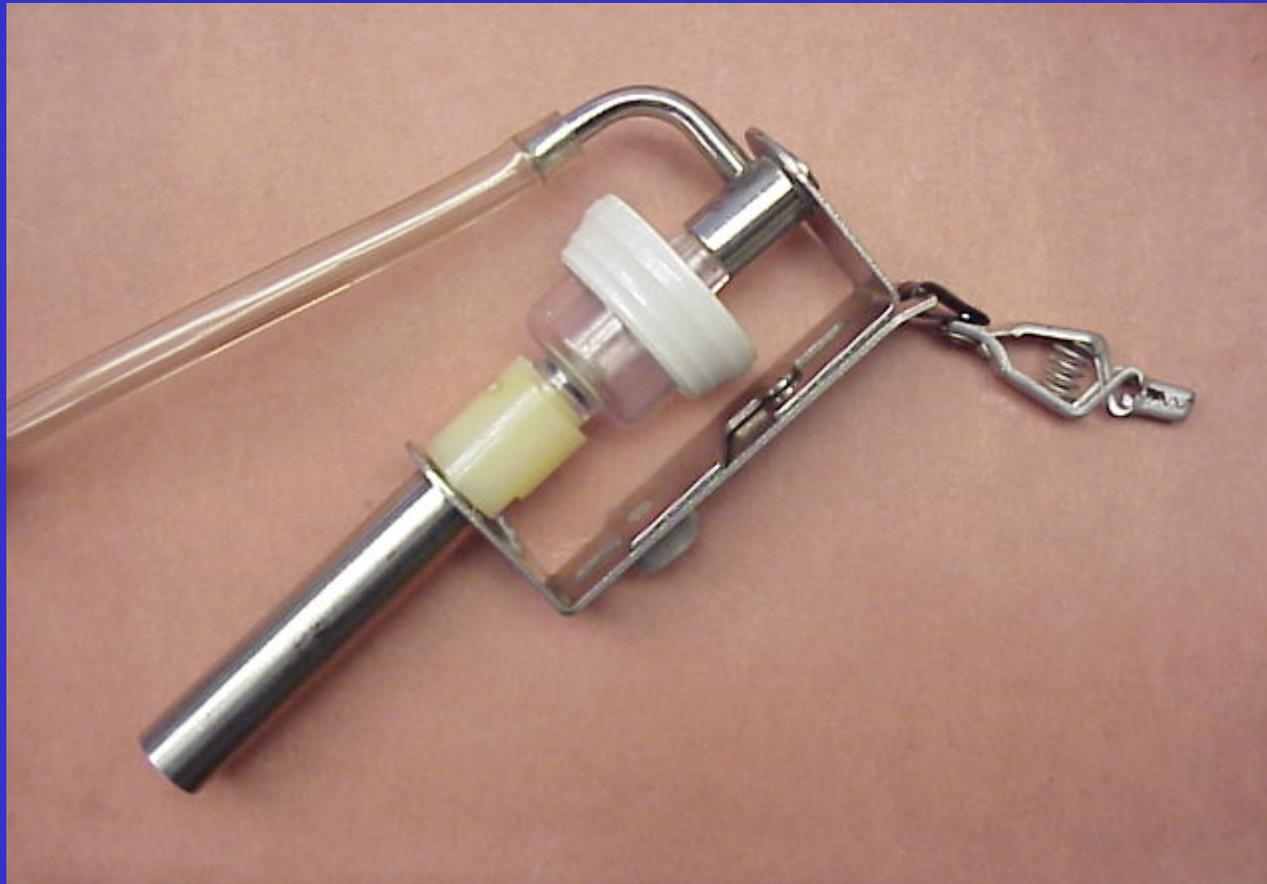
Lab reports OC, EC, TC concentration



DPM Filter Cassette



DPM filter cassette and cyclone components



**DPM filter cassette mounted
on cyclone in lapel holder**



**DPM sampling train
connected to sampling pump**



Personal DPM sampler



Area DPM Sampler

Sampling Train

- ❖ Sampling train is the hose, filter, and cyclone assembly attached to the pump
- ❖ When assembling and attaching, insure:
 - Connections tight
 - Proper components are included (cyclone, DPM cassette)
 - Filter is new (not used for calibration), properly labeled, plugs removed, in correct direction (will only fit properly if correctly installed)
 - Cyclone and hoses are clean

Conduct Sampling

- ❖ Always follow manufacturer instructions
 - Sampling equipment
 - Accessories
 - Use and environmental limitations (duration, temperature, humidity)
- ❖ Pre-calibrate
- ❖ Sample
- ❖ Post-calibrate

Why Calibrate Pumps ?

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- ❖ For DPM sampling, cyclone and submicron impactor function properly ONLY IF pump operates at 1.7 liters/min

Pump Calibration

- ❖ **Connect sampling train to pump and calibration device**
 - Air must be drawn through calibration device, then through sampling train, then into pump (must be in this order)
- ❖ **Turn on pump (let run for 10 minutes)**
- ❖ **Adjust pump speed until desired flow rate is achieved**
 - 1.7 liters/minute for DPM

DPM Sampling Priorities

- ❖ **Sample the underground occupation(s), miner(s), and shift(s) where the greatest DPM exposures are most likely to be experienced**
- ❖ **Take as many samples as necessary to document “worst case” conditions**

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If these conditions are controlled to acceptable levels, all other exposures will be at least as well controlled

Documentation of Sampling

- ❖ All sampling must be documented
 - Observations of employee work activities
 - PPE (respirator type, is it being used?)
 - Sampling information (type of sampling, calibration data, pump type and serial number, filter number, etc.)
 - Environmental conditions
 - Sources of DPM and DPM controls in use
 - Periodic sampling equipment checks
- ❖ Helps to use a form or checklist
- ❖ MSHA DPM Field Notes form is available

Labs and Filters

❖ Need a lab to process samples

- Thermo-Optical Analysis for DPM

❖ Many analytical labs to choose from:

Data Chem, Salt Lake City, UT

Clayton Group Services, Novi, MI

Mine Ventilation Services, Fresno, CA

Sunset Laboratory, Forest Grove, OR

Galson Laboratories, E. Syracuse, NY

Wisconsin Occupational Health Laboratory, Madison, WI

Environmental Diagnostics Laboratory, Clearwater, FL

LA Testing, Los Alamitos, CA

EMSL Analytical, Westmont, NJ

Galson Laboratories, E. Syracuse, NY

NATLSCO, Long Grove, IL

RJ Lee Group, Monroeville, PA

(We regret any inadvertent omissions. MSHA does not endorse these laboratories nor does it take responsibility for, or exercise control over these organizations.)

❖ Filter options

- SKC disposable DPM filter (tandem quartz fiber)

Shift Weighted Average

- ❖ Problem: PEL based on 8 hr exposure
- ❖ What happens when exposure is longer than 8 hrs?
- ❖ Solution: Adjust exposure concentration to compensate for longer exposure time
- ❖ ***SHIFT WEIGHTED AVERAGE***

Shift Weighted Average

- ❖ SWA is determined by adjusting measured DPM concentration

$$\text{DPM conc.} = \frac{\text{Weight of DPM}}{\text{Pump Flow Rate} \times \text{Sample Time} \times 0.001}$$

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***All MSHA compliance
determinations based on SWA***

What Do I Do With My Sample Results?

❖ Compare SWA to PEL

- SWA Below Limit - OK
- SWA Above Limit - Overexposure

❖ If SWA Exceeds PEL:

- Provide respiratory protection per §57.5060
- Implement additional engineering and/or work practice controls
- Conduct additional sampling to verify effectiveness of new controls (SWA < PEL)

❖ Maintain records of sampling method and 5-yr sampling history

Sampling and Analytic Error

- ❖ Every measurement involves error
 - Sampling (pump flow rate, air density)
 - Laboratory (chemical analysis)
- ❖ Laboratory results incorporate uncertainty range (Error Factor)
- ❖ Example:
 - PEL = $308 \mu\text{g}/\text{m}^3$
 - SWA = $335 \mu\text{g}/\text{m}^3 \pm 12\%$
 - Actual concentration is somewhere between $295 \mu\text{g}/\text{m}^3$ and $375 \mu\text{g}/\text{m}^3$
- ❖ *Actual SWA Could Be Less Than Limit*

What Do I Need To Do So I Will Be In Compliance With § 57.5071

- ❖ Review all available DPM sampling information on your mine
 - Company records
 - MSHA sampling history
- ❖ Develop and implement DPM sampling strategy
 - Is sampling necessary ? If so, who, where, when ?
 - Do we perform sampling, or hire contractor ?
 - Sampling equipment (buy, borrow, rent) ?
 - Line up an analytical laboratory
 - Conduct sampling, analyze results, take action
 - Insure all requirements of §57.5071 satisfied
- ❖ Develop a good recordkeeping system

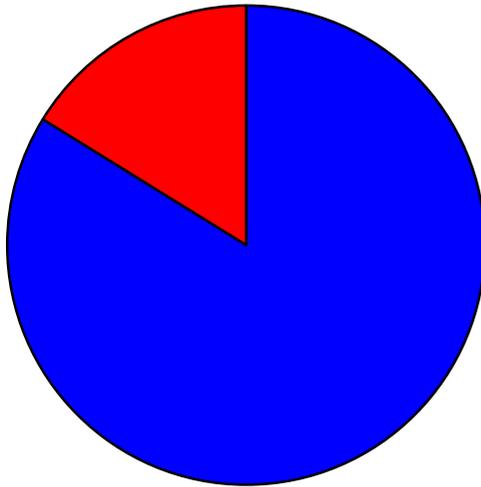
DPM Citations Issued Since 5/18/2006

(Includes a few citations that were later vacated)

| | | | |
|----------|----|--------------|-----------|
| Nevada | 22 | Colorado | 2 |
| Missouri | 10 | Kansas | 2 |
| Montana | 9 | Oregon | 2 |
| Indiana | 8 | Illinois | 1 |
| New York | 6 | Ohio | 1 |
| Alaska | 5 | Nebraska | 1 |
| Iowa | 4 | Pennsylvania | 1 |
| Kentucky | 3 | TOTAL | 77 |

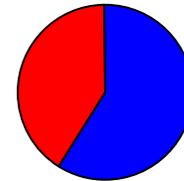
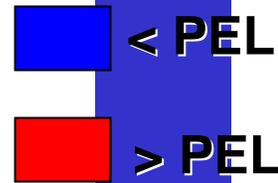
DPM Compliance Sampling Results Since May 18, 2006

Entire U.S.



729 samples total
117 > PEL (16%)
77 citations (10.5%)

Nevada



53 samples total
22 > PEL (42%)
13 citations (24.5%)

MNM Citation Rates Since 6/6/2005

Resp. Quartz vs. Noise vs. DPM

(Includes a few citations that were later vacated)

| | <u>Samples</u> | <u>Citations</u> | <u>Citation Rate</u> |
|--------------|----------------|------------------|----------------------|
| Resp. Quartz | 4471 | 168 | 3.8% |
| Noise | 5131 | 377 | 7.3% |
| <i>DPM</i> | <i>729</i> | <i>77</i> | <i>10.5%</i> |

Thank You

